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ROYAL GARDENS, KEW.

BULLETIN

OF

MISCELLANEOUS INFORMATION.

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LXX.—INHAMBANE COPAL.

(*Copaifera Gorskiana*, Benth.)

The term copal is commercially applied to various hard gum-resins yielded by certain tropical and sub-tropical trees. In the majority of cases copal is obtained in a semi-fossil state on land where no trees at present are found, but where, at one time, large forests existed. In other cases what may be termed recent copal is a gum-resin in a comparatively fresh state collected from living trees or from trees in a state of decay.

There are numerous commercial distinctions between varieties of copal. It is unnecessary here to do more than draw attention to some of the chief plants yielding these substances. Zanzibar copal, or Anime, one of the most valuable of any now used in commerce, is obtained from *Trachylobium Hornemannianum*, Heyne. Sierra Leone copal is derived from *Copaifera Guibourtiana*, Benth. What are known as Lisbon copal, recent and fosssil; pebbly copal from Accra, on the Gold Coast,

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and Benguila copal, are all probably furnished by species of *Copaifera*, but material for their determination has not yet been received. Sierra Leone and other fossil African copals are the foundation of all fine varnishes. The locust tree of tropical South America (*Hymenæa Courbaril*, L.) yields a resinous substance resembling gum anime, which is found in masses in cavities, and at the bases of old trees. The well-known Dammar, or Kauri, gum of New Zealand is yielded by *Dammara australis*, Lamb. This is extensively excavated from the sites of old forests, and the exports from New Zealand in 1883 were 6,518 tons, of the value of 336,606*l*. Indian copal, or white dammar, used in varnish on the Malabar coast, is obtained from *Vateria indica*, L. Black dammar is the produce of *Canarium strictum*, Roxb.

Recently a new source of copal has been discovered in South-east Africa, which has created a good deal of interest.

The first particulars respecting this new copal communicated to this establishment are summarised in a communication made by Mr. Thiselton Dyer to the Linnean Society (*Journ. Linn. Soc.*, vol. xx. pp. 406–8) :—

In the course of last year we received from the Foreign Office a copy of a despatch (dated June 11th, 1882) to the Secretary of State from Mr. Henry G. O'Neill, Her Majesty's Consul for Mozambique. I extract the following passages from it* :—

"I have the honour to report, that from Mr. James Heathcote, of Inhambane (the trader that was employed by me for the recovery of the body of the late Captain Wybrants), I have received information of the discovery of a considerable tract of copal forest, which, if it should turn out to be as rich as he anticipates, will add a valuable export to the trade of that place. He had just returned from an expedition to the interior, and writes : 'The forest where I obtained this gum, of which I 'send you specimens (I have collected six tons), is fully 200 miles long. 'It is a belt which runs parallel with the coast and the first range of 'mountains ; from Inhambane it is nearly 100 miles to get right into it. 'The distance of the forest from Inhambane may retard its being opened 'up ; but its discovery adds to the known wealth of the district, and a 'new export to the place.' Mr. Heathcote further adds : 'The native 'name of the gum is *Stakate* and *Staka ;* the Zulu name for the gum is '*Inthlaka*. . . . . The tree domineers over all. The gum has a 'beautiful odour if pounded and burnt, also if boiled in a pot of water.' The ordinary gum copal tree of the mainland of Zanzibar and Mozambique though, as a rule, lofty, is by no means of the striking stature indicated by Mr. Heathcote."

The first thing that struck us from a superficial examination of the specimens sent by Mr. O'Neill was that they were entirely different in appearance to ordinary East African copal (the produce of *Trachylobium Hornemannianum*) exported from Zanzibar. They consisted in part of waterworn pebbles, and very much resemble the Accra copal† which is exported from the West Coast of Africa. They are destitute of the characteristic goose-skin texture frequently observed in Zanzibar

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* Some extracts from Consol O'Neill's despatch appeared in *Nature* for Aug. 10, 1882, p. 351, but I reproduce the substance here in order to make the whole account complete.

† An interesting paper by Dr. Welwitsch on West African Copals, in *Journ. Linn. Soc.*, Bot. IX., pp. 287–302, may be consulted ; it does not, however, carry our knowledge very far.

copal, and, as Sir John Kirk informs me, possess an entirely different odour.

That the product was not identical with Zanzibar copal was further established by a report with which Messrs. Robert Ingham Clark and Company, the well-known varnish-makers of West Ham Abbey, very kindly furnished us upon some of the specimens which we sent to them for examination. After pointing out the resemblance to Accra copal, they continue :—"They [the specimens] contain (some more than "others) a considerable quantity of essential oil and have an average "melting-point of 337° Fahr. This is not high, and we consider that "they are a semi-fossil exudation. It is very difficult to give an exact "commercial value to them ; but as they *now* are, and mixing them "together to represent one bulk, we should say their value would be "about 80*l.* to 100*l.* a ton . . . . Certain descriptions of animi "shipped in a very clean and picked state from Zanzibar sell in this "market as high as 400*l.* a ton."

With a further despatch dated February 14th, 1883, Consul O'Neill sent samples of the leaves and bark of the tree yielding Inhambane copal. Supposing that Consul O'Neill's collectors have made no mistake in the identification, Professor Oliver, the Keeper of the Kew Herbarium, was satisfied that the leaves afforded sufficient data to fix the species as *Copaifera Gorskiana*, Benth. Although it is stated in the *Flora of Tropical Africa* (vol. ii. p. 315), on the authority of Sir John Kirk, that this tree affords a good hard timber, it was not known before that it yielded a copal suitable for commercial purposes.

The identification is the more interesting on account of the resemblance of Inhambane to Accra copal. The latter has long been suspected to be produced by a species of *Copaifera*. Sierra Leone copal is ascertained to be derived from *Copaifera Guibourtiana*, Benth. Students of tropical African botany are familiar with the occurrence ef the same genera, and even species on both the east and west coasts. *Landolphia florida*, one of the African rubber-vines, is a striking example of this wide distribution.

Subsequent to the date of the above communication, further specimens of leaves and fruit were received from Mr. Heathcote on the 5th February 1886. The latter fortunately contained good seeds, and from these several hundred plants were raised. Mr. Heathcote states :—
"Many tons of copal have now been exported from Inhambane. For "some choice pieces I have received as high as 13*l.* 10*s.* per cwt. The "average price realised on larger lots has been 7*l.* per cwt. The "forest containing the trees extends from the River Sabia in a south-"westerly direction as far as Beleni . . . . . the soil is some-"what sandy, with a sub-soil containing limestone . . . . the "seeds are ripe on the trees in May."

For a description of the species see Oliver's *Flora of Tropical Africa*, vol. ii. p. 315. There is a figure under the name of *Gorskia conjugata*, Boll, in Peters' *Mossambique*, t. 13.

Inhambane copal has been successfully introduced during the past year from Kew to India, Fiji, Singapore, Jamaica, Trinidad, Demerara, tropical parts of Australia, and Dominica. Plants for Ceylon and other colonies are ready to be distributed next summer. It is important to bear in mind that this plant yields a valuable timber as well as copal.

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LXXI.—THE CULTIVATION OF RICE IN BENGAL.

The following interesting summary of information respecting rice culture in Bengal has been communicated by Mr. C. B. Clarke, F.R.S., well known as an accomplished Indian botanist. Mr. C. B. Clarke was a member of the Bengal Education Department and is the author of several papers published at Calcutta, but inaccessible in England, dealing with rice culture. Possessing considerable practical knowledge of rural economy, his views on this subject, based on personal observation, are stated with perfect frankness; even those who may be indisposed to agree with him altogether must feel that on a subject of this nature it is very desirable to throw as much light as possible:—

Dear Mr. Thiselton Dyer, Kew, 10th October 1888.

In reply to your request to furnish you with the substance of what I have published in Bengal regarding the growth of rice, I willingly write as much as I can recollect; but I have none of the original papers at hand, nor any notes, and what I now write must be deficient altogether in quantities, and imperfect in many other ways. My account refers to the Lieutenant-Governorship of Bengal only.

In Bengal several hundred varieties of rice are distinguished, named, and cultivated. I have written of them under three main heads, viz.:—

(1.) Rowa; harvested in November–January; grown mainly in small fields surrounded by a bank 4–12 inches high, and often at no period of growth more than 6–12 inches deep in water.

(2.) Amon; harvested in November–January; swamp-rice, often 2–8 feet (locally even 14 feet) deep in water for several weeks in August and September.

(3.) Owsh; harvested June–August.

It is perhaps hardly necessary to state that there are numerous sorts of rice intermediate to the above three. The Rowa is the most valuable crop; and I proceed to describe the cultivation of what I have taken as the type variety.

The Rowa Crop.

Rowa can only be grown where there is some clay in the soil to prevent the water slipping away; the finest Rowa is grown where the small bank round each little field retains the late rains (which are usually much broken), so that throughout October the Rowa is always in mud, but rarely 6 inches deep in the water. On such Rowa land there is very rarely any second crop; the land remains untouched from December or January (when one crop comes off) till July–September (when the next is dibbled). It grows a Rowa crop every year—without any manure—and has done so from time immemorial; and in order to find any case of serious failure in the Rowa crop of Central and East Bengal I believe it is necessary to go back beyond human memory when an altogether abnormal failure in the rainy season occurred. The Bengalees, with that inverted view of political economy favourite to them, have several times given me, as the reason why a second crop in the year is not taken from the Rowa land, that the Rowa is so valuable that it is ample to pay the rent and leave the cultivator a living. The rains in Bengal become heavy between 15th and 30th June; towards the end of July (it might be done earlier), and more often between 1st August and 10th September, the cultivator commences what we call (by a misemploy of the English language) ploughing. His implement is a vertical post with a flat shoe at the base, all of wood; it is, in brief, a simple cultivator. Many of the fields

do not contain 10 perches, and very many not a rood, in area; and within the small plot bounded by his little bank the cultivator goes round and round and across and back again in a very promiscuous way. After the "plough" comes the "mowee," a small heavy wooden frame; but the "plough" often goes over the ground behind the mowee again. By the combined operation of these implements the field to a depth of 4 to 6 inches is reduced to a stiff mud, the water remaining mostly in the upper portion; the weeds, especially the creeping grasses, having been thoroughly picked out and laid mostly on the little bank (this is the important feature in the process; they are largely collected by the mowee, which works as a very coarse bush-harrow). The rice is then dibbled (it is taken about a foot high from a seed-bed) with a stick; it gets a firm hold on the "pan," the surface of the undisturbed soil. The seed-bed is usually in the village or near the cultivator's hut, *i.e.*, in unflooded land, where rice for dibbling is raised in a dense mass on a very small plot; and if not dibbled out exactly at the right age soon gets very yellow. The Rowa rice requires nothing more done to it till the day it is harvested; where the land is terraced, and to a less extent in the apparently dead flat of Bengal, the water requires a little watching and regulation. But no weeding is required; the Rowa has a fine start of the weeds; there should be no creeping grasses left; a great multitude of annual weeds of many species grow in the Rowa fields, but they are mostly low, and they exert no appreciable effect on the crop.

The Rowa crop depends very little on the early setting in of the rains (the Government printed reports I am aware imply a contradiction of this statement), but almost entirely on the rain holding on in the autumn. The Bengalee expects rain at least once a week during October, and enough to prevent his rice drying up before quite the end of the month; if he gets this he has a full crop (and I say whether he dibbled early or as late as 15th August to 10th September). If the rain holds on steadily (*i.e.*, sufficient in quantity and at sufficiently short intervals to prevent the Rowa field getting dry) to the beginning of November (as I have known it do nearly half the seasons I have witnessed) the crop is a bumper. If the rain stops by 10th–15th October, so that the Rowa fields then dry up there may be a three-quarter crop. If the rain stops before the end of September, as it did in Orissa in 1869, the crop (at least all the August–September dibbled) fails. Also, if the rain stops by middle of October, so that the rice dries up, a late downpour in November or December (which I have seen twice) does harm rather than good.

The Rowa rice is the food of the upper classes in Bengal. It is to be noted that the cultivator except at harvest (when the weather is set fine and he works easily) does not do a day's work on his Rowa land in the year, except about a couple of days at dibbling time. Those who propose to teach the Bengalee cultivator a more elaborate system of rice farming must ponder this fact well.

The Amon Crop.

Amon, the deep-water rice, grows with the water; the flag of the rice just resting on the surface of the water. The height of the Amon depends on the height to which the water rises. Occasionally, and very locally, the water may rise very suddenly two feet so as to cover the rice completely which then perishes, but in general the water rises (in Central and East Bengal) very steadily till the latter end of August (or till the middle of September sometimes) and then sinks away as

steadily—often more rapidly. The way in which the Amon is got in varies very greatly with the circumstances of the land.

In Central and Eastern Bengal (as in all alluvial deltas) the banks of the anastomosing rivers are usually the most elevated grounds, and on these very commonly the villages stand. As you walk in the cold season from one river to the next you insensibly descend from the river-bank till you come to the "bheel" which at this season may be shallow, or mud, or wholly dried up; and you insensibly ascend similarly from the bheel till you come to the bank of the next river. Now this bheel will begin to swell in spring—sometimes as early as April (when the April showers are strong), sometimes not till June if these showers are light, and May dry. As each band of land round the jheel gets softened it has to be tilled and planted with rice before it is submerged more than a very few inches. The bheel will swell till it covers the whole country except the narrow belt by the rivers occupied by the villages; and the getting in the Amon may thus extend for three months. If the water rises very nicely and steadily the Amon may be dibbled, provided there is a seed-bed of rice just ready at the moment required, or the cultivator may be driven to sow it broadcast; or if the water rises by sudden jumps the cultivators may fail to plant considerable areas altogether. The Amon, if dibbled, is dibbled much earlier than the Rowa. Amon is not only a coarser, less valuable rice than Rowa, but owing to its being often sown broadcast, owing to its being longer on the ground, and owing to its frequently being put in hastily, it is much more damaged by weeds of various kinds than Rowa, and in particular it is liable to the pest of Oori which causes severe toil to the cultivator. "Oori" is believed to be the wild state of *Oryza sativa*, the origin of our cultivated rices, and being so nearly allied it is therefore the most pestiferous weed of rice. When Amon is about 2 to 4 feet deep in water the cultivators will be seen proceeding in their boats to their fields; they then get down into the water and remain hours (usually having large round hats of plaited strips of bamboo on their heads) drawing the Oori and piling it on their boats, which return to the village as small floating haystacks; the Oori is eaten by the cows which at this season are kept chiefly in long sheds in the village, just above the water level. I do not know how, in this young state, the cultivators tell the Oori from the Amon. I cannot. The Oori grain is good in quality, but so very caducous that it is impossible to harvest it on any considerable scale. The children often do, with the aid of a large cloth, harvest the Oori that fruits in ditches and waste corners and so collect a considerable quantity of good grain. The typical Amon swamp-rice has often a pink tinge on the husked grain; it is the main food of the masses in East and Central Bengal, but considered of very inferior quality to Rowa and is always much cheaper. [In Behar the masses do not get rice as the principal part of their food.]

The Owsh or Spring Rice Crop.

Owsh, or spring rice, is much smaller in quantity than the preceding two classes, though there are highly-valued varieties raised in Zillah Burisal. But, as a whole, the Owsh may be treated as generally of very small importance. In the famine of 1874 a fine Owsh crop in Central Bengal (Zillah Jessore, &c.) early reduced the pressure for food. On Owsh land there is nearly always grown annually a second crop that is not rice.

On concluding the above description, and before going on to criticise fashionable schemes for teaching the natives how to grow rice better, I

should warn you that many points in the above description have been controverted ; and in particular it has been asserted, not only by Calcutta English newspapers, but by Government officers, that there exists no such rice as I have described as Rowa.

Renovation of Soil in Rice Fields.

In the Rowa fields, as I describe them, the rice gets only rain-water, and the water drains from the fields into the rivers. Liebig says that the reason why rice can be grown in Bengal every year in the same fields without manure is because the rivers annually replenish the soil by a layer of rich silt. My critics see that the rice round Calcutta town and along the two principal railways in Bengal is all Amon ; and they think that rice could not grow for ever without the aid of the silt. I called their attention to Roxburgh's *Flora Indica*, v. 2, p. 202, where he maintains that much of the rice land in Asia receives no help except what the air and rains yield (*i.e.*, as fully explained, neither inundation nor any material quantity of manure) ; yet that these fields have for probably thousands of years continued to yield annually a large crop of rice, thirty to sixty fold. Roxburgh barely ventures to suggest that a recuperation of the soil takes place between January and June.

On the west side of the great Bengal Plain, from Rajmahl and Burdwan to Orissa, the hills rise in many places gradually, and we see a great quantity of terraced rice ; it is clear that these fields cannot be inundated from the rivers. As we proceed further into the western hills we find V-shaped valleys terraced in narrow curved platforms ; the rain-water is led down gradually from one to another ; there is on the outer edge of each platform a little bank, usually not more than 6 to 12 inches high, and the rice is therefore never more than a few inches deep in water ; this terraced rice is a subvariety of Rowa in my classification, and it gets nothing but air and rain-water ; it is the kind of rice land Roxburgh refers to, his account being drawn up in the Circars immediately south of Orissa. Not rarely in this kind of rice cultivation a bank is drawn across the upper part of the valley and a tank formed immediately above the rice platforms ; from this reserve the rice can be watered after the rain stops and the crop almost ensured. Now in all these cases it is manifest that the rice fields can get no manuring by silt from the rivers.

In the north and east of Bengal the hills rise very suddenly from the plains ; there is little terraced rice, but there is a broad belt of land in which there is enough clay in the soil for Rowa, that extends from Mymensingh to Chittagong. In the most valuable rice land, as on the right bank of the Bruhmapootra, throughout the Zilla of Mymensingh, the water runs from the rice fields to the Bruhmapootra, and the fields are never deep in water. The land in the thoroughly inundated districts, as south-west Dacca and Furidpore, is too sandy to grow Rowa rice, and it is much less valuable than the belt of Rowa land near the base of the hills. Roxburgh says in the place above cited (v. 2, p. 202) that "the "best rice lands are those that are overflowed annually by the inunda- "dations of large rivers." But he is speaking of the Circars ; he probably never saw the fine Rowa land of Mymensingh, Comilla, and Noakhili. The gross produce of swamp rice may be about as large as that of Rowa, though raised at a greater cost of labour ; but the value of the crop per acre is very much less.

I am prepared to go further and to doubt whether even swamp rice gets much silt. Where the water from a muddy rapid river gets through its bank (which is the highest part of the country) and spreads out over

the lower country beyond, it loses its velocity very fast, and therefore drops all its silt in the "bank," *i.e.*, near the river it has left. If this were not so the bheels would soon all fill up, and the "banks" (they may be a quarter of a mile wide) would not be the highest parts of the country. In fact, in swamp rice, the water is perfectly still and black, evidently all or very nearly all rain-water. Where the land is well silted, as in the case of large sandbanks, it is impossible to grow any rice but a little Owsh, and usually not that till the land has been made more tenacious by a few crops of indigo or some other leguminous crop. I have no doubt of the most important fact that a large class of rice fields in Bengal, annually cropped without manure or silting, maintain a perennial fertility; though, like Roxburgh, I may not be prepared with explanation. John Scott, who was in 1870 curator of the Calcutta Botanic Garden, was of opinion that in these rice fields the recuperative power of the soil is sufficient, under the sun and rain of Bengal, to go on growing the present crops of rice indefinitely.

Improvement in Rice Culture.

Next I come to proposals that have been made to teach the Bengalees how to grow rice better. A favourite proposal is to give them an English plough, which shall go deeper than the native cultivator and bring up fresh soil. I pass by the practical difficulty that in none of the terraced fields and in none of the small fields, without a revolution in boundaries and customs, could such a plough be used. The plough is the most perfect implement yet devised for setting in creeping grasses, as couch; it cuts the creeping rhisome into convenient lengths, and by the turnover buries the fragments deep. If in England a farmer is about to put in a large field of barley or beans and sees a patch of couch grass in the fallow he misses that patch with the plough, and at some dry time in early summer he turns in a party of boys to tease the grass thoroughly out. Some bad (or about-to-quit) farmers will plough a field full of creeping grass to get a corn crop; they get an inferior corn crop and the field is then found (in vulgar parlance) to be "clean run out," or (as I should rather put it) to be so thoroughly foul that it will take two years at least and a heavy outlay to get it straight. Now in India we have, not one or two, but many creeping grasses to contend with; the safety of the Bengalee cultivator is that he has a hard pan, impervious to creeping grasses, which his cultivator travels upon but never has broken. He gets the creeping grasses well out of the top 4–6 inches of his soil, and has a full crop on his shallow tilth if the water is right. I may add that if a Bengal field was ploughed with an English plough just before dibbing, I doubt whether the rice would get a firm enough hold.

I have never inspected a Government experimental farm. Dr. Watt tells me that on one of these he has known the skilled European agriculturalist plough deep with an English plough in April, as soon as the first rains had softened the ground a little. The field was then left till July or August when it was tilled in the native fashion and dibbled with rice. By this plan a much better crop of rice was obtained in a season when the rain ran short than in the adjoining native fields.

I have no doubt this would be the result. The English skilled agriculturist in this case would have been careful to have the land perfectly clean before he commenced on it with his English plough.

I am not at all sanguine of success in applying the English plough in Bengalee hands to rice growing in Bengal. I fancy it would be exceedingly difficult to induce a Bengali cultivator to clean his land

thoroughly before ploughing, or to undertake any extra labour to ensure a better crop in a bad season ; he would say that if the rain should not last on the average time that would be the will of Providence. Moreover (as see below) I think there is something easier than deep ploughing which might be done to assist the crop when the rain stops too early.

Manuring Rice Fields.

A second favourite proposal is that the Bengalee cultivator should be taught to manure his rice. It has been urged on the Lieutenant-Governor of Bengal (in a formal agricultural council), that the lowest classes in Bengal should be taught chemistry, but I will pass that by. The Bengalee cultivator has little manure and he applies what he has mainly to his cold weather crops. There is a considerable quantity of cowdung used for fuel. It might be possible to forbid by police ukase the burning of cowdung in Calcutta and its suburban municipalities ; I do not think it would be remunerative to purchase extraneous manures. The effect of manure may be considered as similar to that of deep ploughing, and it must be recollected that it is quite possible to get corn too strong. The rice crops, when a full one, often suffers before harvest by getting laid into the mud and water when the country is drying up in November ; this is especially the case with the Amon.

Experiments with Carolina Rice.

A third Government plan has been to introduce experimentally foreign prolific sorts of rice. The Carolina rice has a large grain ; it does not follow that the produce per acre would be larger, far less that it would be more valuable than that of Bengalee small-grained kinds. Government for 20 years past has been sending round this Carolina rice for trial in Bengal. A bag of seed rice is sent to each collector ; the collector hands it over to some Bengalee gentleman supposed to take an interest in agriculture ; the reports finally got in by the Bengal Secretariat are found on the whole unfavourable. In 1870 the Bengal Government called on the Calcutta Botanic Garden to try Carolina rice. The Curator, Mr. John Scott, grew it on ordinary rice land outside by Bengalee cultivators in their own way, merely supervising them to see that the rice was forward in the seed-bed, the land thoroughly cleaned, and the dibbling early. There was a very heavy crop, but no native dealer would purchase it, and it was finally bought by a European merchant for export to London. Government is still (up to three years ago) sending round bags of experimental Carolina rice to the collectors. The Bengalees distinguish shades of flavour in rice ; they do not like American or Burmese rice ; they do not like large-grained coarse rice ; and they do not like newly harvested rice, as they say it disagrees with them extremely. The Rowa rice in Mymensingh, harvested in December, is kept in raised well-thatched granaries till the following August, when the Calcutta traders' large boats arrive ; it reaches Calcutta just aged enough for the Calcutta baboos to eat. In the 1874 famine Government imported Burmese rice largely into Behar and distributed rations of it to those employed on the famine relief works. But these recipients largely sold their rations to traders, by whom the Burmese rice was exported back to Burma.

Suggestions for Improving Rice Culture.

I concluded my first (1868) paper on rice by saying that I did not think we had much to teach the Bengalees in rice growing ; and this statement did not, I fear, conduce to the popularity of that paper. I

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will venture here to mention a few points where I see the best chance of improvements being effected.

One most important point is that the Rowa should be dibbled out as early as possible. This is in general not done; the rain comes, and by the middle of July the cultivator tills his field but the plants for dibbling are not ready; a month or six weeks later often he cultivates his field over again and dibbles it. One reason of this is the deep-seated Bengalee principle never to do to-day what can possibly be put off till to-morrow, and to do everything incompletely; he says, "it is not quite as it should "be, Sahib, but it will act (chullibai)." The real difficulty in introducing any improvement in Bengal is to infuse some energy into the native character. In the majority of the seasons I have seen in Bengal I know no reason why the rice that was dibbled between 1st August and 7th September might not have been dibbled between 1st July and 7th August. The advantage of promptness would outweigh, I believe, all the deep ploughing and manuring that will ever be introduced in Bengal. If the rain holds on through October it nowise injures the forward rice; while if the rain stops between 1st and 15th October the forward rice gives nevertheless an excellent crop. Many of the simple savages on the frontiers of Bengal exhibit much more punctuality in business than the civilized Bengalees. I cannot help suspecting that the magnificent rice crops I have seen (in the Naga hills in the extreme north-east no less than in the Kolhan in the extreme south-west) are due to their promptness in dibbling; but I have never spent a whole season among these peoples.

A difficulty is encountered, it is true, in dibbling rice in Bengal from the uncertainty of foreseeing the exact time when the land will be ready for dibbling, so that it is impossible to raise the seed-bed to fit; the rice must be a certain length for dibbling and cannot stand over long in the seed bed, so that the native cultivator plants his seed-bed in fair average time; rather late than otherwise. It thus often happens that the field is wet enough for tilth before the seed bed is ready for dibbling; and in one season I saw in Burdwan the water came so late that the seed-bed rice was seriously injured (and some dead) before it could be dibbled and a deficiency in the Burdwan crop ensued. But this difficulty could surely be met by some combination among the cultivators to have a series of seed-beds "to follow in succession."

Railways and Tanks.

For the increase of the gross rice produce in Bengal (the real object of Government), the most important point is improved communication. There are still very large areas in Chota Nagpore, Assam, and the margin of the Soondreebun, which would be made to grow rice, if communications gave a good market. Also irrigation tanks could be largely increased in Chota Nagpore, where the long gradual slopes at the head-of the valleys lend themselves to such. Communications in Bengal mean the enlightenment of the population; not merely by the penetration of European enterprise, for no well-educated Bengalee wishes to live in the wilderness, and the opening of a railway produces a line of good schools, where before, at great direct cost to Government in paying discontented teachers, no satisfactory schools could be kept.

Whatever is to be taught the Bengalee cultivator must be taught by example. It is no use whatever to lecture him; it is absurd to expect him to adopt a new, outlandish, and troublesome process unless you show him clearly that it is remunerative. You must therefore have model farms in central, accessible situations where this can be shown.

Other Crops.

I fear that it will be very difficult for Government to show remunerative improvements in the cultivation of rice; there are many native crops where I believe such may be shown. Europeans, I notice, even of very low skill, usually grow sugar cane to a profit; it is a crop that responds to deep and clean cultivation, and to manure. I have often thought that if one tenth of the English energy and capital had been devoted to the wild date palm (*Phœnix sylvestris*) that have been devoted to tea, the results would have been very surprising. Few educated natives take any real interest in agriculture; on the European tea plantations Bengalee baboos are kept as clerks in the office; but as overseers, both in the field and in the factory, Paharias are usually preferred to Bengalees. The Bengalee cultivator esteems rice as the great crop; and, if he tries to grow any other, be it sugar cane or onions, his one idea is irrigation. My view is that rice is the very last crop on which we should attempt to give the Bengalee instruction.

C. B. Clarke.

LXXII.—SILKWORM THORN.

(*Cudrania triloba*, Hance.)

With Plate.

This is a tree evidently of wide distribution in China, and known as the Silkworm Thorn. Its Chinese name is *Tsa*. It belongs to the tribe *Artocarpeæ* of the natural order Urticaceæ. As an ornamental shrubby tree it was introduced to this country in 1872, and a plant (bearing staminate flowers only) growing at Kew has proved sufficiently hardy to stand the winter in the open ground. The juvenile shoots are armed with strong, straight-pointed, axillary spines, while the leaves on the same shoots are broadly three-lobed. The central lobe is ovate-deltoid and much longer than the side lobes. The leaves of mature, fruiting branches are entire, broadly elliptical or obovate-elliptical, smooth above, pale beneath, $2\frac{1}{2}$—$4\frac{1}{2}$ inches long and $1\frac{1}{4}$—$2\frac{3}{4}$ inches broad; the petioles are $\frac{1}{3}$—1 inch long. The staminate and pistillate (dioecious) flowers are in globose heads (capitula) single or in pairs in the axils of the leaves. The fruiting capitulum is elliptical, compressed, somewhat hard, and shining.

The plant was described under its present name by the late Dr. Hance, in *Journal of Botany*, vol. VI. (1868), p. 49. See also a detailed account in *Journal of Botany*, vol. XXI. (1883), pp. 145–149. The synonymy is *Cudrania tricuspidata*, Bur. in Lav. Arb. Segrez. 243, and *Maclura tricuspidata*, Carr. in Rev. Hort. 1864, 390, fig. 37, and 1872, 56, fig. 7. It is also figured and described in Nicholson, *Dict. Gard.* ii. 312–3.

Its extensive distribution in China may be gathered from the fact that there are specimens in the Kew Herbarium from Shantung, Shanghai, Ningpo, Ichang, Kiangsi, Kwanlung, and Hooper Island, Corean Archipelago. For a very complete set of specimens we are indebted to Dr. Henry, of Ichang, who is an indefatigable and careful observer of Chinese plants. Dr. Henry states that the Silkworm Thorn is considered to be as good for silkworms as the mulberry, but it is not used so long as mulberry leaves can be had, because the tree is thorny and it is troublesome to pick off the leaves. It is given chiefly to adult silk-

worms, and as mulberry leaves soon become finished it is much used. The tree attains a height of about 20 feet.

The *Bulletin* is indebted to the Bentham Trustees for the opportunity to add a plate of this interesting plant from the *Icones Plantarum*, vol. VIII., pl. 1792.

Explanation of Plate.—Fig. 1. Staminate flower. 2. Stamen and suotending perianth segment. 3. Pistillate flower, immersed in its capitulum. 4. Single female flower removed. 5. Same in section. 6. Portion of fruiting capitulum. 7. Fruit and style base. 8. Fruit laid open. 9. Embryo. *Enlarged.*

LXXIII.—JAMAICA INDIA RUBBER.

(*Forsteronia floribunda*, G. Don.)

Latterly attention has been drawn in the *Kew Bulletin* to more than one direction in which it may be hoped to enlarge our supplies of india-rubber, and correspondents of this establishment, at home and abroad, have suggested improved methods of tapping the trees and coagulating the milk, so as to produce the best qualities of commercial rubber.

The principal papers on these subjects are, Nicaragua, or Central American rubber (*Castilloa elastica*), *Kew Bulletin*, Dec. 1887, p. 13; Macwarrieballi or Demerara rubber (*Forsteronia gracilis*), March 1888, p. 69; and Lagos rubber (*Ficus Vogelii*), November 1888, p. 253.

To these may now be added a further note on a new rubber plant, native of Jamaica, which has already been referred to in the Kew Bulletin for March of the present year (pp. 70, 71.) as *Forsteronia floribunda* (Grisebach's *Flora, British West Indian Islands*, p. 412). This plant is known locally as the milk wythe, or milk vine. It appears to be entirely confined to the Island of Jamaica, and is found as a climbing shrub in the mountain woods of the interior in the parishes of Manchester and Saint Elizabeth. It is closely allied to the Demerara rubber plant already mentioned, but the caoutchouc, judging by the results of experiments made by the India-rubber and Gutta-percha Company of Silvertown, appears to lend itself more readily to the requirement of manufacture.

Attention was first drawn to the Jamaica rubber plant in the Report of the Director of the Botanical Department, 1883, p. 17, and again in the Report for the year 1884, pp. 46–47, from which the above particulars have been taken :—

ROYAL GARDENS, KEW, to COLONIAL OFFICE.

SIR, Royal Gardens Kew, 26th October 1888.

I HAVE the honour to forward herewith the accompanying papers relating to an important india-rubber plant (*Forsteronia floribunda*, G. Don) native of Jamaica which has been in course of investigation by this establishment.

2. The inquiry in regard to this plant was first taken up some time ago, but recently at the request of Kew, the Reverend E. Bassett Key, who throughout has taken a warm interest in the subject, forwarded here a bottle of latex for the purpose of determining the commercial value of the rubber.

M. S. del. et lith.

Cudrania triloba, Hance.

3. The report of the India-rubber, Gutta-percha, and Telegraph Company of Silvertown, obtained through S. W. Silver, Esq., F.L.S., proves that this native rubber of Jamaica is of high industrial value, and it might give rise to an important local industry if it were found possible to increase the plant by cultivation and to pursue the subject in a systematic manner.

4. On this latter point the Government of Jamaica will, no doubt, consult Mr. Fawcett, Director of the Botanical Department.

5. The supply of india-rubber as a forest product is destined to fall far short of the supply, and under these circumstances the Government of Jamaica might be glad to be placed in possession of information as regards a native rubber plant which stands so high in intrinsic value. Various samples of commercial rubber manufactured from the Jamaica plant are enclosed.

I am, &c.
(Signed) D. Morris.

Edward Wingfield, Esq.,
Colonial Office.

[*Enclosure.*]

India-rubber, Gutta-percha, and Telegraph Works Company to Royal Gardens, Kew.

Silvertown, London, E., 17th October 1888.

The sample received with letter from Kew, dated 12th September 1888, consisted of a lactescent juice partially coagulated, with a strongly acid reaction. Fortunately it was contained in a stout glass bottle, about 10 ounces capacity.

The portion which had coagulated in the bottle could be removed only by fracturing the same. It was rinsed out so as to free it from adherent non-solidified milk, &c., and treated subsequently by itself. It will be referred to hereafter as A.

The non-coagulated portion was mixed with about twice its volume of water with about an ounce (fluid measure) ordinary acetic acid, British Pharmacopœia strength, &c. After a few days' exposure the coagulum rose to the surface in a fairly coherent form, and was collected and squeezed. This portion will be referred to hereafter as B.

The residual liquid was evaporated to complete dryness (and yielded less than half-ounce of solid, principally saline, matter, gum, &c.) so as to ascertain whether the juice itself contained any principle likely to produce a detrimental effect on the product, by any subsequent process of coagulation or inspissation. So far as we can see, the portion of the juice or sap which is rendered insoluble by evaporation would give the rubber a dark colour, and render it short. The finest Para rubber contains the entire juice or sap of the tree; the aqueous portion evaporates during the process of coagulating. It is doubtful whether the juice of the *Forsteronia floribunda* could with advantage be treated in this way. The juices of india-rubber producing plants are alkaline or neutral, never acid. By a process of fermentation which soon sets in the nitrogenous or other constituents of the juice produce sufficient acid to cause a separation of caoutchouc. Whether the *Forsteronia floribunda* juice if exposed in an open vessel would part with the whole of the caoutchouc in this way would be worth trying, with the recently collected juices.

It is quite possible that it would be an advantage to recover the caoutchouc as it was coagulated without using any artificial means; the

mother-liquor should not be thrown away, but should be continually worked up with fresh juice.

The method recently given by Mr. Alvan Millson for the recovery of caoutchouc from the "Abba" tree, is admirably adapted for the treatment of the juice of the *Forsteronia floribunda*.

The rubber from this plant is so remarkably good that no time should be lost in submitting samples prepared on the spot. The rubber cannot be seriously deteriorated by any process likely to be used in its recovery.

There is no doubt but that the examination of the natural juice of a plant will, in most cases, enable one to point out what precautions should be taken to ensure the best result; still the fact must not be lost sight of that such an examination might lead one to suggest methods difficult of being carried out under surrounding circumstances.

The juice of the *Forsteronia floribunda* yields roundly one pound of dry and washed caoutchouc, or about 22 ounces of ordinary crude caoutchouc as generally met with, per quart.

A. About 2½ ounces of this product was recovered, the weight being that of the washed and dried article. In colour and strength it approaches more nearly to the better descriptions of Para rubber. Mixed with sulphur and treated it vulcanized perfectly, in being solid, firm, and strong. It is a light colour when vulcanized.

B. About 1½ ounce of this product was recovered when washed and dried. It was much darker in colour than sample marked A. This remark applies also to the washed product, but it is not nearly so tough as A.

LXXIV.—SEEDLINGS OF SUGAR CANE AT BARBADOS.

(*Saccharum officinarum*, L.)

The sugar cane is one of the most valuable economic plants we possess. It has been cultivated for so long a period that the primitive habitat of the species according to De Candolle, is unknown.* Bentham in *Flora of Hong Kong*, p. 420, states that "We have no authentic "record of any really wild station of the common sugar cane." Further than this, in common with many plants that have been for a long time under cultivation and reproduced solely by means of buds and suckers, the sugar cane so rarely produces muture fruits that no one, as far as we are aware, has ever seen them. Certainly in the rich Herbarium at Kew there are no seed-bearing specimens. In botanical works the subject is often referred to, but apparently only to restate the fact that botanists like McFadyen in the West Indies and Roxburgh in India "have never seen the seeds of the sugar cane."†

Schacht is one of the few persons who has given a good analysis of the flower of the sugar cane including the pistil; he also had not seen the ripe seed.

In discussing the problem how far the saccharine qualities of the sugar cane could be improved on the same lines as those so successfully adopted with regard to the beet it was lately pointed out in a letter addressed to the Colonial Office that, owing to the power of

* *Origin of Cultivated Plants* (1884), p. 755.

† *Hooker's Botanical Miscellany* (1830), Vol. I. p. 95, tab. 26.

producing fertile seeds having apparently been lost by the sugar cane, it was impracticable to deal with it by means of cross fertilization or by the ordinary course of seminal selection. It was further pointed out that new and improved varieties amongst sugar canes were to be looked for amongst bud variations, and planters were advised to mark any canes that showed a departure from the type and cultivate them separately for experimental purposes, with a view to test their yield in sugar. Attention having thus been directed to the subject by official notices published in sugar-producing colonies, several communications have been received at Kew from persons who believed that they were able to afford some information on the point whether the sugar cane produces seed or not.

First, as regards the actual seeds of the sugar cane. A correspondent at Fiji, in forwarding a small packet to Kew in April last, stated "Some "time ago there was published in the Government Gazette of this "colony an extract from a letter from you in reference to sugar-cane "seed. I have been 18 years in sugar-producing countries, and have "never observed sugar-cane seed until within the last month, when one "of my sons brought me a head fully ripened from a garden in my "neighbourhood. Some time afterwards I went to see the sort of cane "from which the seed had been gathered, but the plant was dug up and "I could only learn that it was a purplish cane." The seed sent by this correspondent proved not to be the seed of a *Saccharum* at all; it was the seed of a *Sorghum*, and probably of *S. vulgare*, the common millet or Guinea corn.

Recently, however, a statement has reached Kew, from a trustworthy source, that seedling sugar canes had been found at Barbados, and that plants were in course of being raised at the Botanical Station in that island, under the care of Professor Harrison and Mr. Bovell.

Mr. J. B. Harrison is Island professor of chemistry and agricultural science at Barbados, and in conjunction with Mr. T. R. Bovell, who is superintendent of Dodd's Reformatory, he has been engaged for the last three years in cultural and chemical experiments with various kinds of sugar canes. The results of these experiments have been published officially by the Government of Barbados, and afford data of a valuable character as regards the effects of various manurial constituents applied to sugar canes, as also the relative merits of new and old varieties of canes now under cultivation in the West Indies.

The statement sent by Professor Harrison appears to prove, in a perfectly natural and circumstantial manner, that a few mature seeds may occasionally be produced by the sugar cane under certain circumstances. It is stated by Rumphius that the sugar cane "never "produces flowers or fruit unless it has remained several years in "a stony place." He does not, however, say whether he ever saw the fruit, nor does he cite any proof of the fact in the shape of seedlings, self-sown or otherwise. The canes that would be likely to produce fruit would be those varieties nearest to the original wild cane, and probably on that account they would be less rich in sugar than the canes improved by a long course of cultivation.

Without expressing a decided opinion on the subject, and in the absence of the specimens themselves, the information supplied by Professor Harrison is, so far, the most tangible of any yet received to show that the cultivated sugar cane may occasionally produce mature fruits.

Government Laboratory, Barbados, 17th September, 1888.

On certain of the higher districts of the island from time to time growths of sugar cane resembling fine grass have been noticed, but in most cases no attempts have been made to cultivate them. Mr. Parris some years ago succeeded in raising a few canes from the cane arrow or flowering shoot. Mr. Clarke did the same with the arrow of the purple transparent cane, but did not succeed in getting the seedlings to flourish, and my wife's father many years ago succeeded in getting the arrows to produce young canes, but not in cultivating them. Knowing these cases, Mr. Bovell and myself considered that a favourable opportunity of examining into this question offered itself during the cultivation of the varieties of canes which we have here. These canes were planted in rows of four broad by 25 feet deep, and so as to have two sets of each kind, in all 36 plots of 18 varieties, planted side by side. The plots were noticeable this year for the number of arrows sent up by some of the varieties. We gave strict orders to the labourers employed in weeding and watching the adjacent land to report to us any grasses springing up upon them in any way differing from the usual weeds. Towards the end of January they reported to us that a few tufts of grass different to the usual kinds were making their appearance. We found these to be growing in a rather narrow belt of the field on one side of the plots and in a little below it, following the direction of the prevailing wind. They were found not only on the surface of the field, but also on the bottom of a drain which had been dug in the field to a depth of 18 inches. Some 80 or 90 plants sprang up at intervals afterwards. We found a good deal of difficulty in keeping them alive, as the sun quickly shrivelled them up; it was necessary to protect them in many cases from the direct rays of the sun and to keep them constantly watered. In this way we succeeded in saving some 64 or 65 plants. Of these we carefully examined three or four so as to ascertain as far we could the absence of any particles of old cane in them. Their mode of growth was quite different to that of canes growing from the eyes of canes. Sixty plants were successfully transplanted, and are being cultivated. At present they are not far enough advanced in their growth to speak with certainty, but there appears to be amongst them several different kinds, probably five or six at the least. If you think it worth while, Mr. Bovell and myself will send you a specimen cane of each sort in January or February next, when they will be sufficiently far advanced to show their characteristics. The way in which they first grow is quite sufficient to account for them not being often noticed upon the fields. The weather here during January last was particularly favourable for their growth, and the fact of different varieties being grown side by side is, of course, much more favourable for the production of seed than the growth of one variety only. I have never heard of the Bourbon cane producing here fertile arrows, in all the alleged cases of fertility the arrows were either those of the purple or white-transparent varieties which, as you are aware, are prone to variation. We shall again attempt this year to obtain the same results. I am anxious to have the benefit of your opinion upon this year's results, as of course, if we can establish the fact of the cane occasionally, and, under certain favourable conditions, producing fertile seed, it will open an important field of investigation.

J. B. Harrison.

LXXV.—RAMIE.

(*Boehmeria nivea*, Hk.)

The difficulties attending the development of the Ramie industry appear to be not confined alone to preparing the fibre as detailed in a recent note on the subject (p. 273).* It is also found that that those who have in a measure been successful in preparing the fibre in commercial quantities are disappointed with the reception this fibre has received at the hands of spinners and manufacturers. In a word, it is found that Ramie fibre when produced is practically unsaleable in the London market at the present time. A correspondent interested in Ramie estates wrote to Kew a short time ago :—

"We have spent much capital on Ramie, but as yet cannot see our "way to commercial success. We have produced excellent filasse, but "the cost has been far too great and the chief difficulty seems to rest, "not in the production of filasse, many systems [if the question of cost "is set aside] have accomplished this, but in the spinning of the filasse "into yarn. No British manufacturing firm appears willing to take up "this business except on terms that would practically give them the "monopoly ; they also require a guaranteed minimum of raw material "which we cannot give."

In a subsequent letter the same correspondent states :—

"I am beginning to think that the only way to succeed with Ramie "is to follow M. Favier's system described in the *Kew Bulletin*, p. 148, "namely, to grow and treat it for a special purpose, and carry it right "on to manufacture. Then it will pay right well. At present the "filasse that would suit one manufacturer would be useless to nine "others, who would want it prepared differently."

Another correspondent, in a letter dated the 14th November, from a different point of view, appears to confirm the experience detailed above :—

" In the *Kew Bulletin* for June last there is an article upon Ramie "or Rhea fibre. Have you had any applications from, or can you put "me in communication with, any manufacturers, who may be disposed "to take up this fibre as a specialty ? I am interested in a works and "process for the preparation of Ramie filasse in the form similar to the "enclosed sample. With our present appliances we could undertake to "deliver it at from ten to twenty cwts. weekly. So far we have not been "able to find any manufacturers here so inclined, and the prepared "material has been sent abroad. If you can render me any assistance "it will be esteemed a favour."

Since the receipt of these letters Kew has been favoured by Messrs. Ide and Christie, a respectable firm of fibre brokers in the City, with a copy of their monthly circular dated the 15th November. In this circular, under the head of China Grass and Ramie, it is stated :—

" On the 31st ulto. a large parcel, consisting of about 130 tons "ribbons and 20 tons ramie or rhea in various stages of preparation, "were put up for public sale, practically without reserve, and after "being widely announced. The prices realised, viz., 8*l*. to 9*l*. per ton "for the ribbons, and 20*l*. to 25*l*. for the ramie, were most disappointing "and testified to the languid interest which this material possesses for "the manufacturers of Europe. Considering the attention with which "planters in various parts of the world regard this material, and the

* *Kew Bulletin*, November 1888, p. 273.

" numberless processes and machines which inventors have set forth " for its manipulation, the result of this sale must be viewed as dis- " tinctly discouraging. It would almost appear as if no true demand " exists for this interesting fibre, and that, in the present attitude of " the manufacturing interest, the application of skill either to cultiva- " tion of the plant or extraction of the 'filasse,' is premature and " misplaced."

In order to understand the present position of the Ramie industry it would be useful to adopt some kind of classification of the details connected with it. In the first place we have the mere business of cultivating the Ramie plant, and of producing stems with the fibre in the best possible condition. This is purely the work of the planter. Secondly, we have the the process or processes necessary to separate the fibre from the stems in the form of ribbons and filasse. It is necessary for many reasons that this should be done either by the planter on the spot, or by a central factory close at hand. Thirdly, we have the purely technical and manufacturing process in which Ramie filasse is taken up by the spinners and utilized in the same manner as cotton, flax, and silk are utilized for the purpose of being made into fabrics.

For our present purpose we may take it for granted that the cultivation of the Ramie plant presents no insuperable difficulty. Also that if a suitable selection of soil is made, and the locality possesses the necessary climatic conditions as regards heat and moisture, there is no reason to doubt that Ramie could be grown to greater or less extent in most of our tropical possessions. As regards the second stage—in which is involved the decortication of the Ramie stems—the problem, as shown at p. 273, is by no means completely solved.

On this really hangs the whole subject. The third stage is disappointing and unsatisfactory, because the second stage is still uncertain; and being thus uncertain the fibre is necessarily produced in small and irregular quantities, and only comes into the market by fits and starts. It would appear that Ramie fibre differs so essentially from cotton and flax that it can only be manipulated and worked into fabrics by means of machinery specially constructed to deal with it. Owing to the comparatively limited supply of Ramie fibre hitherto in the market no large firms of manufacturers have thought it worth while to alter the present, or put up new machinery to work up Ramie fibre. If appliances, or processes for decorticating Ramie in the colonies were already devised, and the fibre came into the market regularly, and in large quantities—say hundreds of tons at a time—there is no doubt manufacturers would be fully prepared to deal with it. At present the industry is practically blocked by the absence of any really successful means of separating the fibre from the stems, and preparing it cheaply and effectively. This, after all, is the identical problem which has baffled solution for the last fifty years.

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